Highway Rail Grade Crossings and the Intelligent Transportation System

Bill Petit

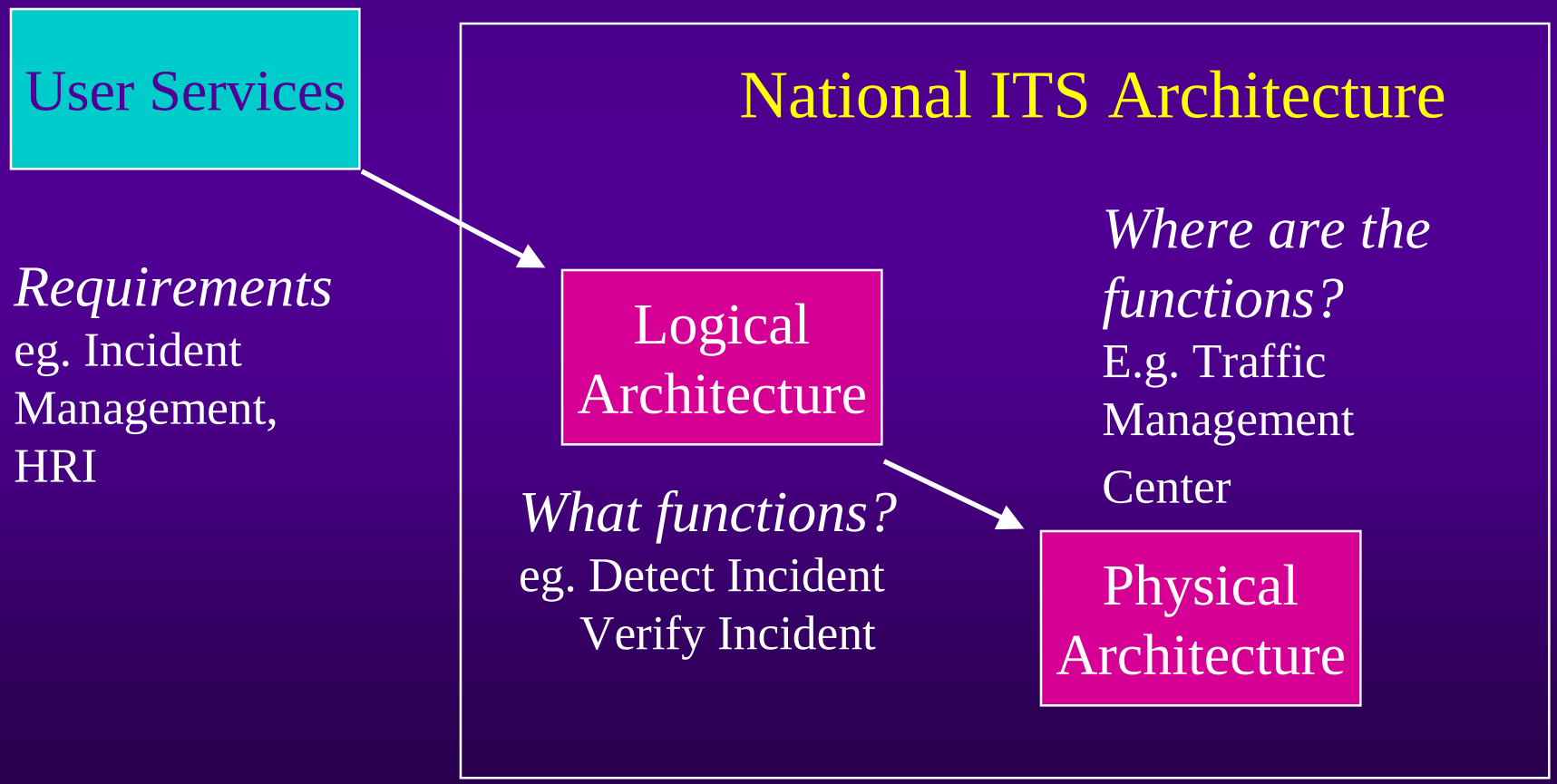
RSAC Meeting

May 15, 2002

Agenda

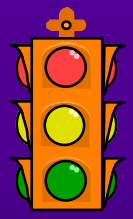
- **What is the National ITS Architecture**
- **Where do Highway Rail Grade Crossings Fit into it**
- **HRI standards development process**
- **IEEE WG14 Standard on the interface between the Railroad Terminator and the Highway Subsystem**

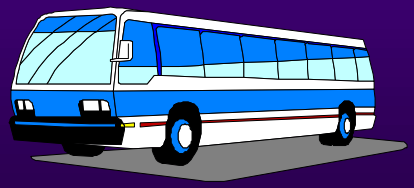
What does the National ITS Architecture Consist of?



What is an architecture?

- **Identifies <u>participants including functions</u>**
- **Provides framework for integrating ITS systems**
- **Identifies Boundaries**





Physical Architecture Subsystems

Travelers

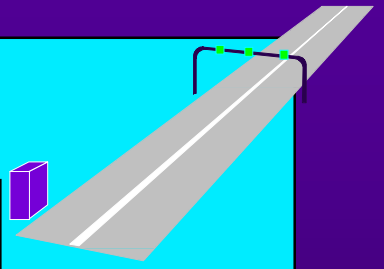
- Remote Traveler Support
- Personal Information Access

Centers

- Traffic Management
- Emergency Management
- Toll Administration
- Commercial Vehicle Administration
- Information Service Provider
- Emissions Management
- Transit Management
- Fleet and Freight Management
- Archived Data Management

Vehicles

- Vehicle
- Transit Vehicle
- Commercial Vehicle
- Emergency Vehicle

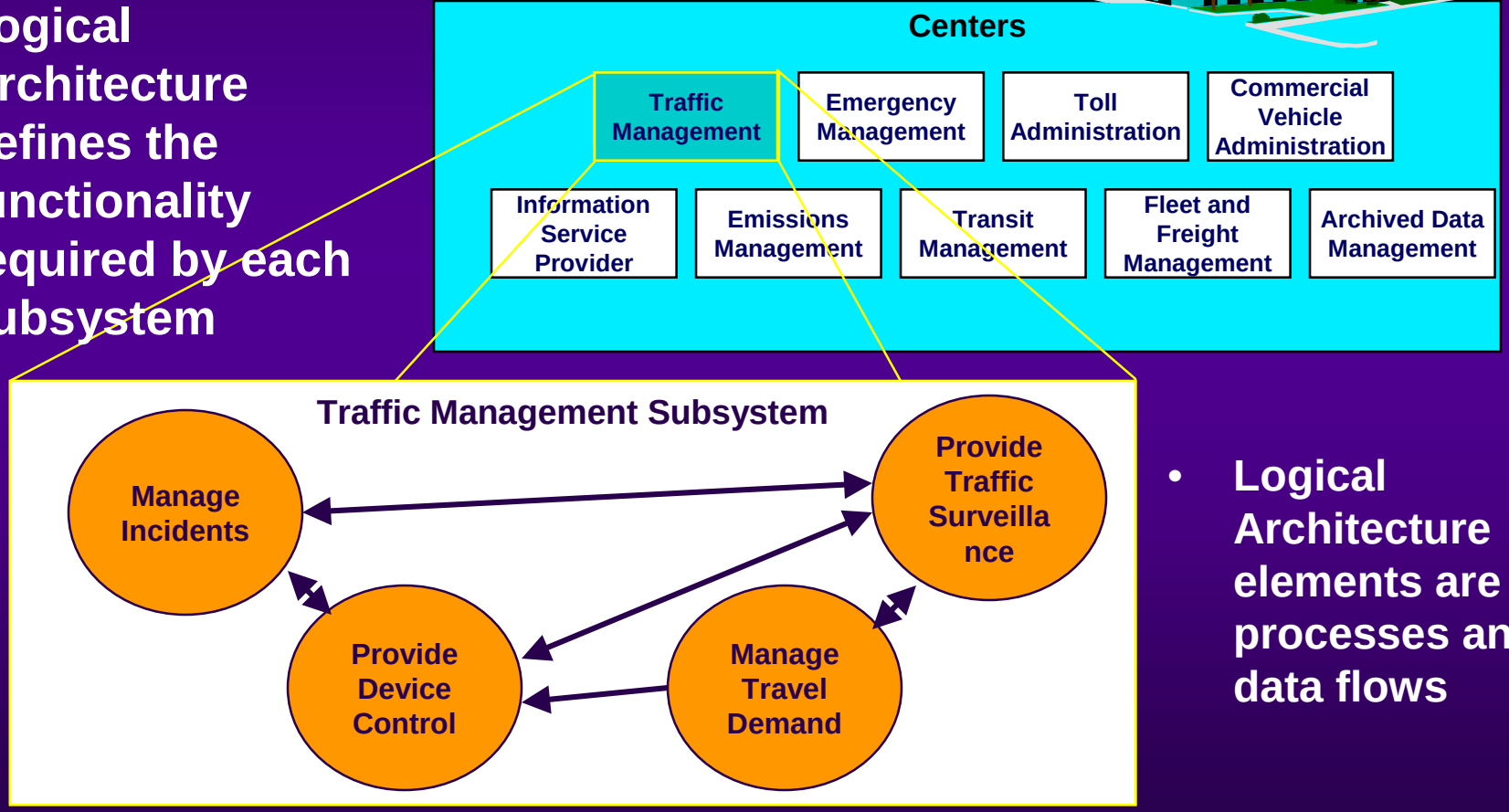


Roadside

- Roadway
- Toll Collection
- Parking Management
- Commercial Vehicle Check

Subsystems are made up of functions

- **Logical Architecture defines the functionality required by each subsystem**



- **Logical Architecture elements are processes and data flows**

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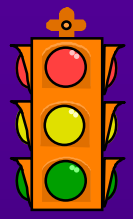
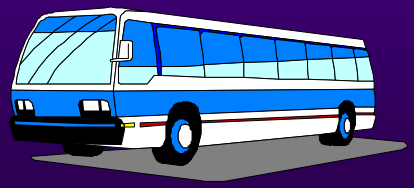
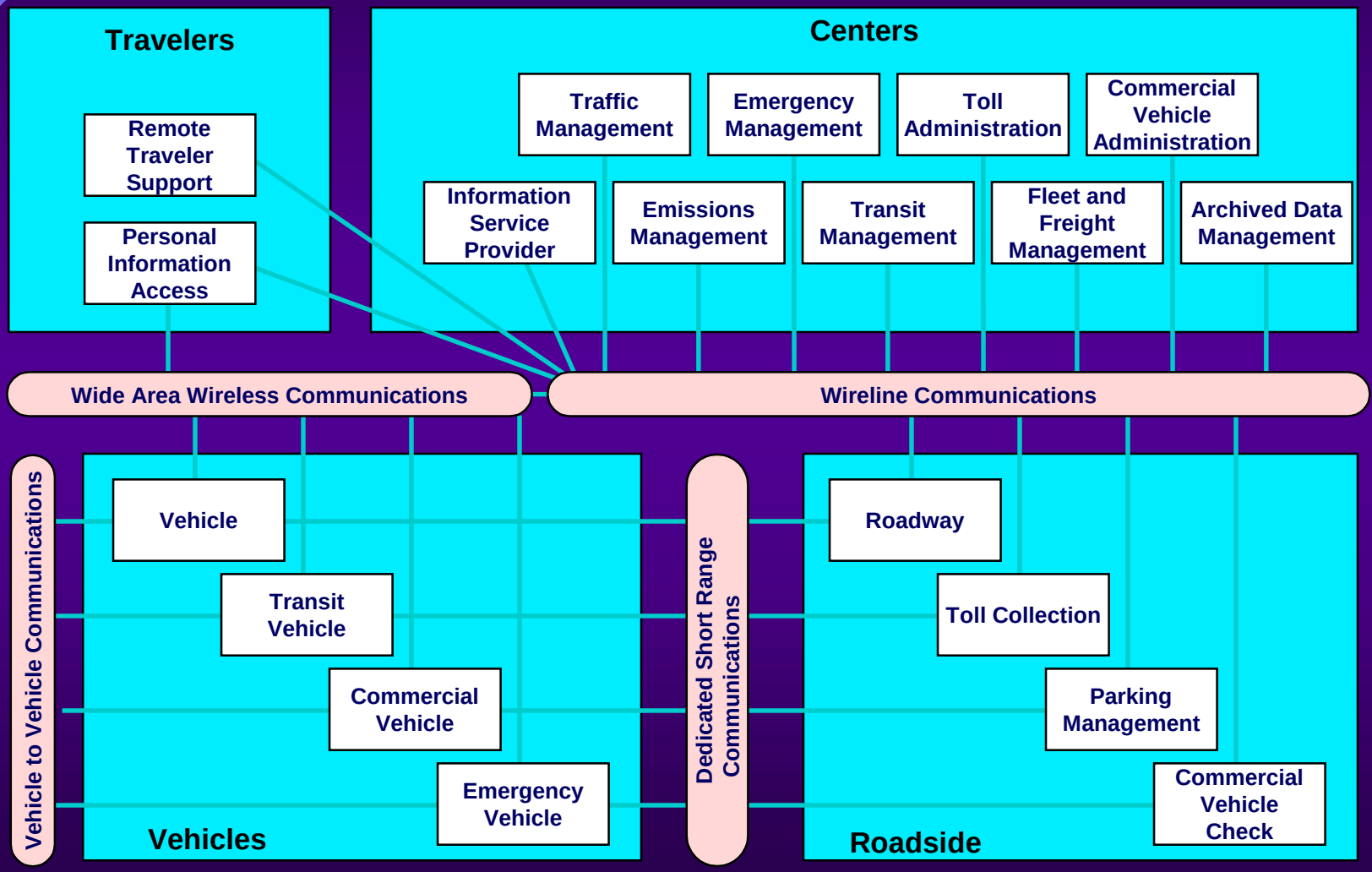
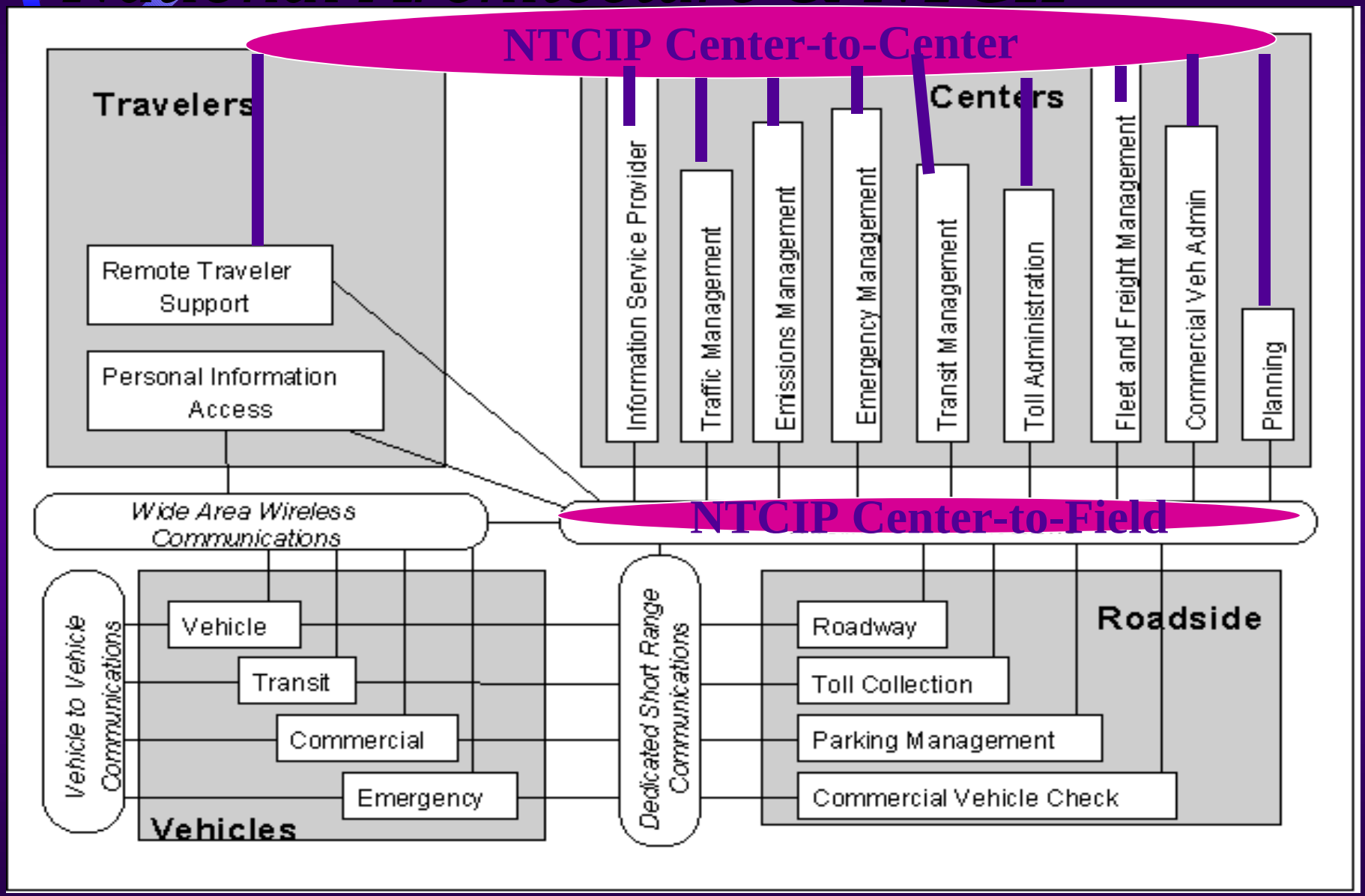




Physical Architecture Subsystems and Interconnects



National Architecture & NTCIP



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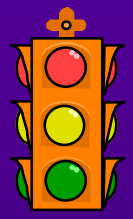
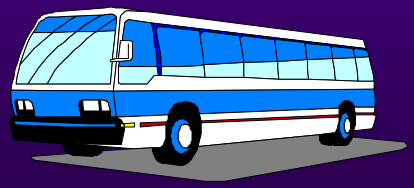
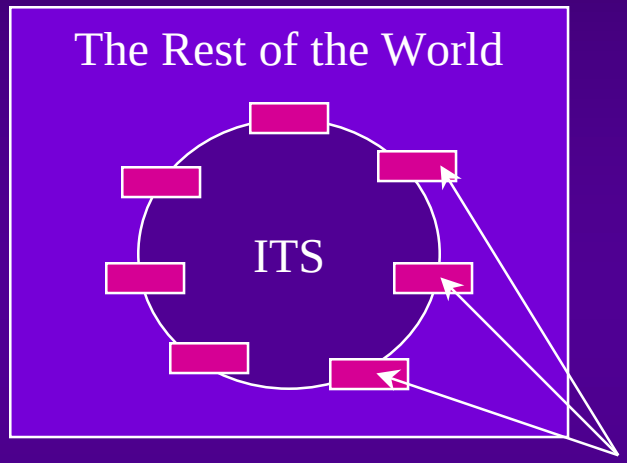




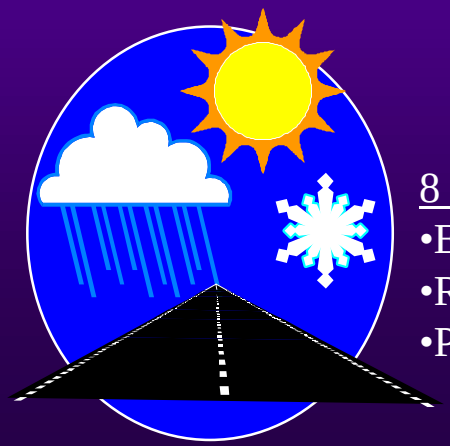
Terminators Establish the Architecture Boundary



Terminators

Users

<u>19 Terminators Including:</u>
- Driver
- Traffic Operations Personnel
- Emergency System Operator



Environment

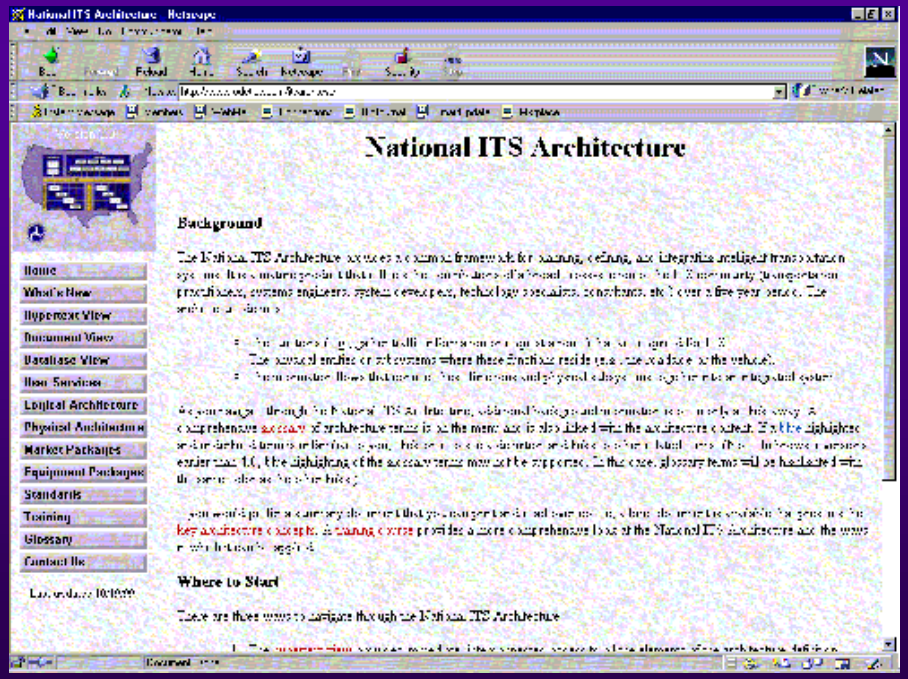
<u>8 Terminators Including:</u>
- Environment
- Roadway
- Potential Obstacles

Related Systems

<u>29 Terminators Including:</u>
- **<u>RR and Transit Systems</u>**
- Financial Institution
- Other Vehicle

National ITS Architecture Release 4.0

- **Where to find it**
  - CD-ROM Order (free) from www.nawgits.com/jpo/
  - Web Page: http://www.iteris.com/itsarch



Highway Rail Grade Crossings in ITS

HRI User Service

Developed 2/96 by FRA, Volpe, and JPL

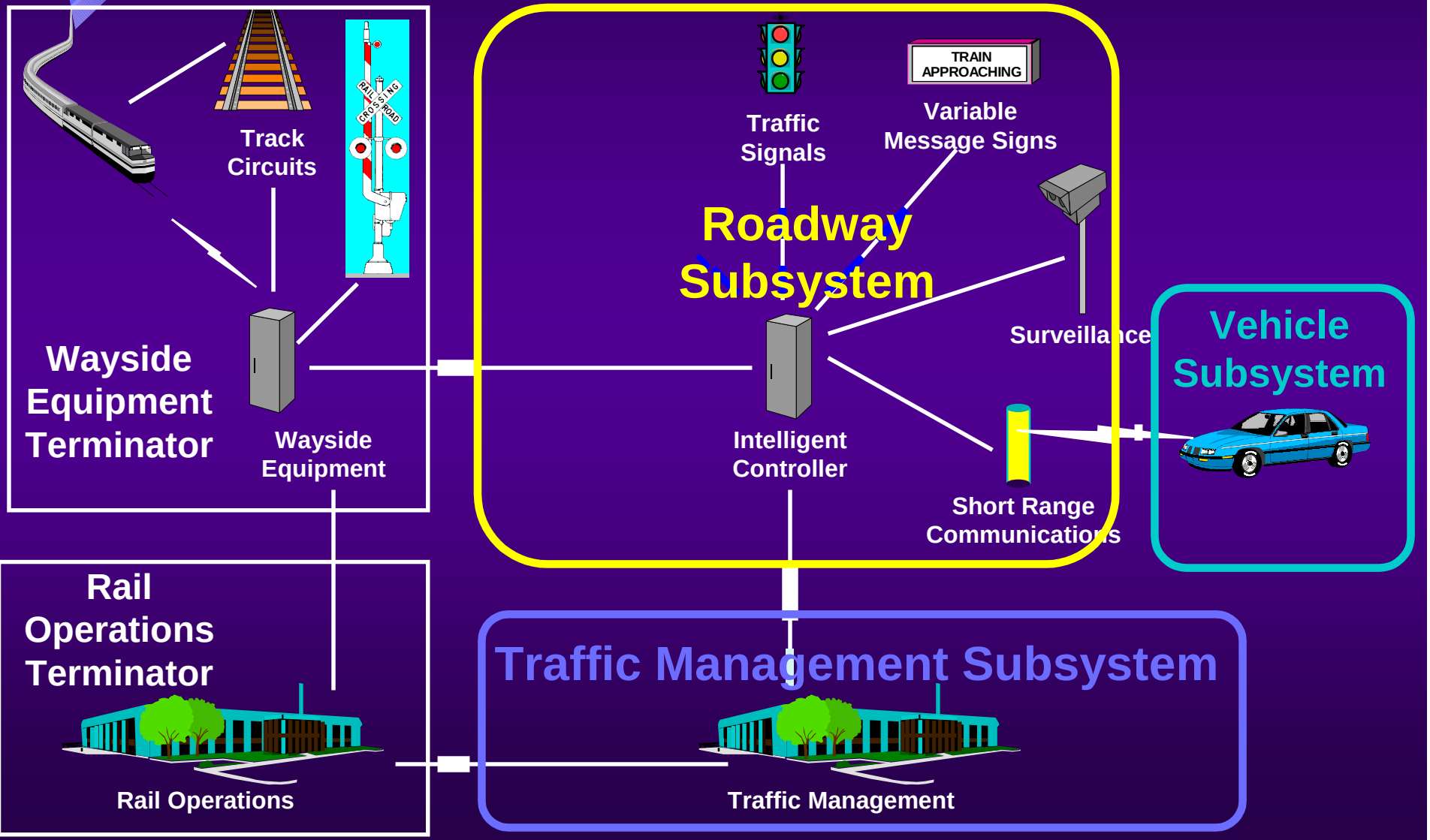
HRI User Service Reqmts

Created 6/96 by FRA and JPL

Nat'l ITS Arch Update

Completed 1/97

The National ITS Architecture: HRI User Service Addition (2)



Development of Highway Rail Grade Crossing ITS Standards

- **Define subsystem interfaces in more detail using ITS Architecture interface definitions as starting point**
- **Participation is voluntary, based on consensus.**
- **Will probably be turned into regulations with Federal funds only going to systems that meet the standards**

Workshop on ITS Standards for Grade Crossings

- **July 22-23, 1999 (FRA, FHWA, ITS JPO, ITS America, etc.)**
- **Objective to identify needed standards and SDO's.**

Workshop Breakout Groups

- **Wayside Equipment and Rail Operations**
- **Roadway Subsystem**
- **Vehicle Subsystem**
- **Traffic Management Subsystem**
- **Human Factors**
- **Special Cases**

Breakout Group Questions

- **Operational and Safety Issues**
- **Available Technology**
- **Interface with ITS Architecture**
- **Where is Standardization Beneficial?**
- **Who should lead and participate in standards?**
- **Institutional Issues, Existing Standards**

Recommended Standards Area

- **Wayside Equipment Terminator to Roadway Subsystem**
  - IEEE Rail Transit Standards Committee WG14
  - Low Cost Warning Devices at low volume crossings (defer)
- **Rail Operations Center to Traffic Management Center**
  - NTCIP (IEEE WG14 support)
- **Traffic Mgmt System to Roadway Subsystem**
  - NTCIP

Recommended Standards Area

- **Roadway Subsystem to Vehicle Subsystem**
  - Expand DSRC message set (IEEE)
  - Standard In-Vehicle Warnings (SAE)
- **Within Traffic Management Subsystem**
  - Expand Data Dictionary (ITE)
  - Human Factors (Defer)

Recommended Standards Area

- **Within Roadway Subsystem**
  - Expand ATIS Data Dictionary (SAE)
  - Link between traffic controller and DSRC system (NTCIP)
  - MUTCD Revisions (Dynamic Message Signs) (FHWA, FRA)
  - Advanced Traffic Controller Standards (NTCIP)

IEEE Rail Transit Interface Stds

- **TCRP G-4 Program Begun in 1996,**
  - Sponsored by FTA, Administered by TRB and TDC (APTA).
- **Approach**
  - establish an institutional framework for developing transit standards within IEEE and ASME engineering societies
  - demonstrate the process by developing one or more needed standards
- **Due to success of project, funding is now done through APTA**

SAFETY & SUPPORT OF REGULATORY PROCESS

- **Public Law 104-113, passed in 1996, Makes it US Government Policy to Use Consensus Standards in Regulatory Activities**
  - OMB Circular A-119 implements this law
- **IEEE Provides us with the Means**

CONSENSUS STANDARDS PRINCIPLES

- **Must be present to meet PL 104-113**
  - Due Process
  - Openness
  - Consensus
  - Balance
  - Right of Appeal

IEEE WG14
P 1570

Standard for the Interface Between The Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection

WG 14 Objectives

- **Develop a Practical Standard of Value to the Industry**
- **Develop Standard in a Professional Environment**
  - All Comments solicited and evaluated
  - Participation from Highway authorities, Traffic Control Suppliers, AAR, BRS, Rail Equipment Suppliers, Consultants, FRA, AREMA, NTCIP, ITE
- **Schedule (based on 6/00 Kickoff)**
  - 8/01 First Draft **COMPLETE**
  - 2/02 Complete Initial Review **COMPLETE**
  - 8/02 Ballot and final Review **COMPLETE**
  - 2/03 Publish
- **Provide support for operations center I/F**

P1570 Scope

This standard defines the logical and physical interfaces, and the performance attributes for the interface between the rail subsystem and the highway subsystem at a highway rail intersection.

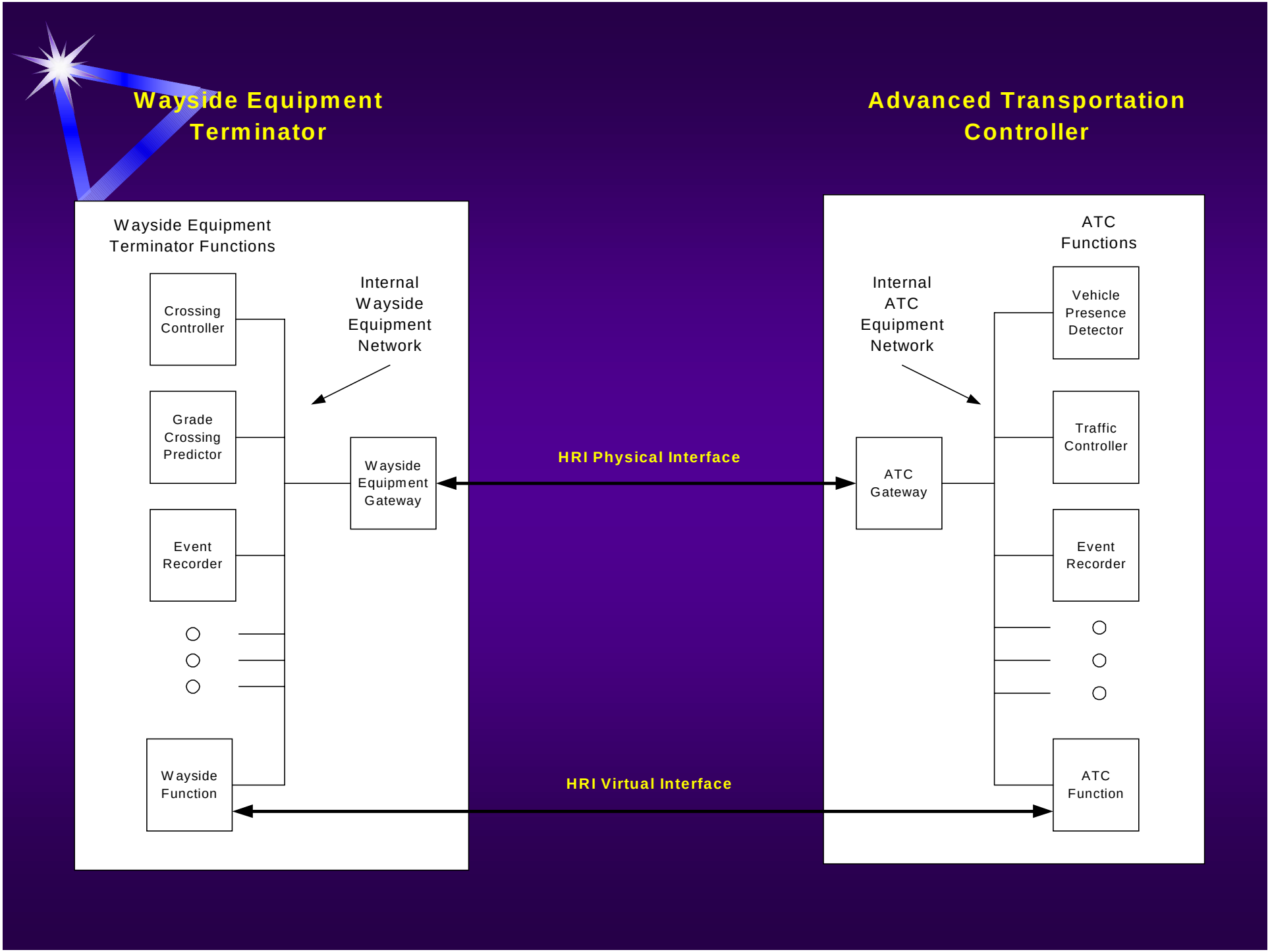
P1570 Purpose

Coordination between the rail subsystem and the highway subsystem is part of creating a National Intelligent Transportation System covering multiple modes of transportation. Existing standards address analog interfaces between these subsystems at the highway rail intersection. This standard will extend that information to include serial digital communication. Standardizing the interface will allow interoperability between a wide variety of equipment and enhance safety through a set of well-defined interface and performance attributes.

Existing Regulations and Practices

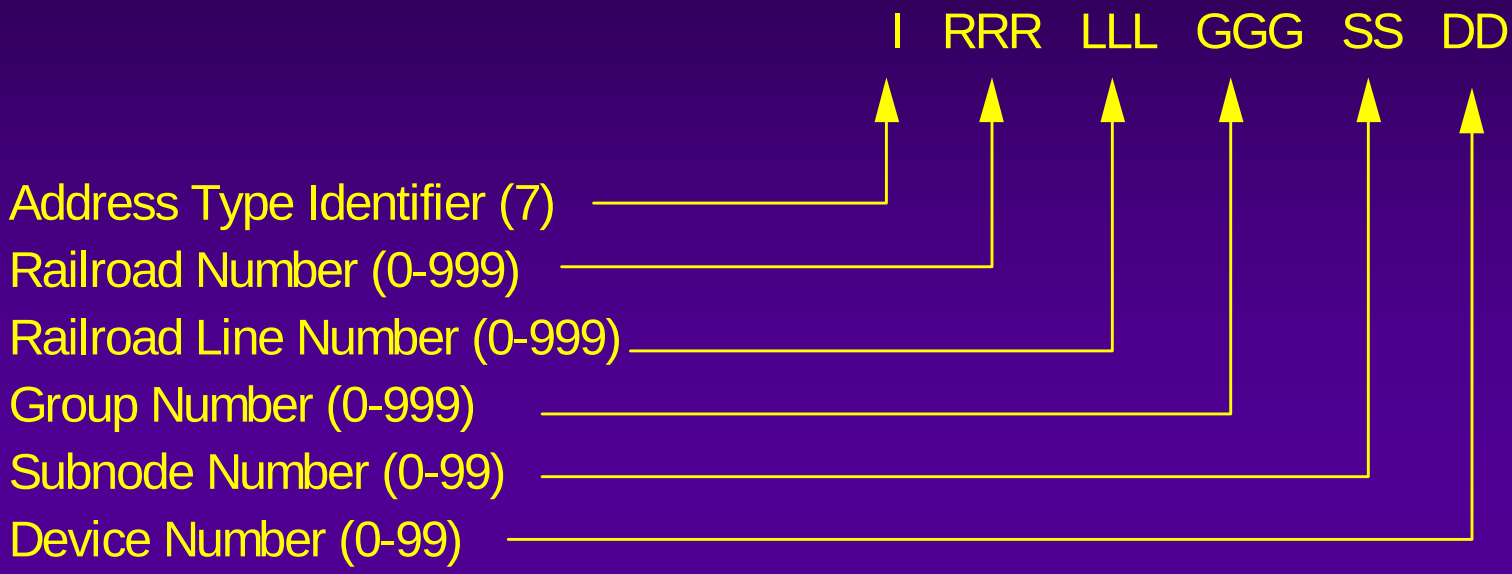
- **FRA Part 234, Draft NPRM**
- **FHWA Title 23 (MUTCD)**
  - Parts 8 and 10
- **AREMA Signal Manual**
- **APTA Grade Crossing Stds**
- **Common Requirements**
  - Safety Critical interface for traffic control (pre-emption) based on closed circuit principle and fail-safe design principles.

Overview of IEEE 1570 Contents


Wayside Equipment Terminator
Advanced Transportation Controller
Wayside Equipment Terminator Functions
Crossing Controller
Grade Crossing Predictor
Event Recorder
Wayside Function
Internal Wayside Equipment Network
Wayside Equipment Gateway
HRI Physical Interface
HRI Virtual Interface
ATC Functions
Internal ATC Equipment Network
ATC Gateway
Vehicle Presence Detector
Traffic Controller
Event Recorder
ATC Function

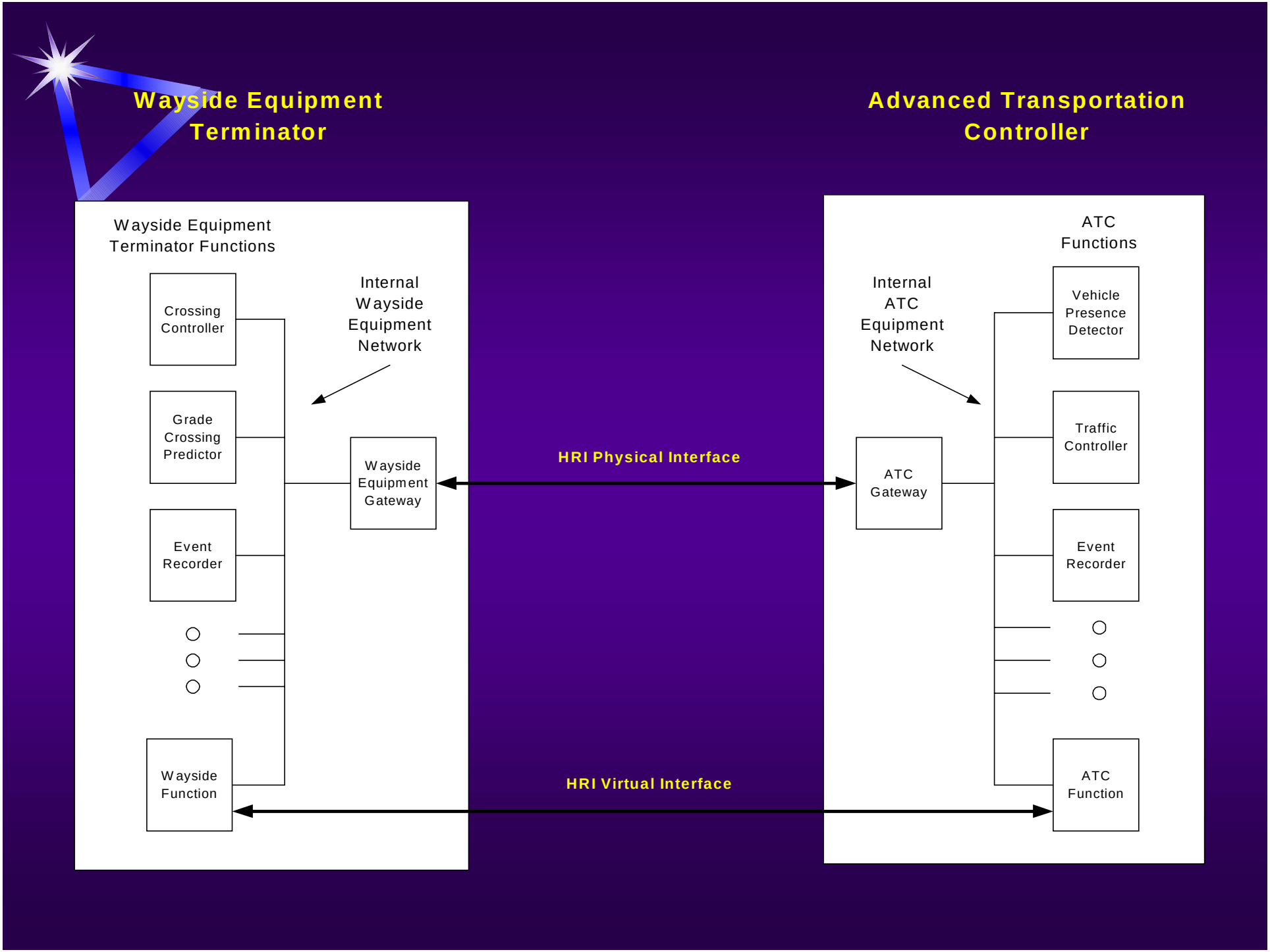
Communications Protocol

- **Upper Layers based on ATCS protocols**
  - Supports required safety and performance
- **Lower Layers provide various alternatives**
  - Point to Point (RS-232)
  - Routing (e.g. IP networks, RS-485)
- **Based on RR defined ATCS Addressing**
  - All Highways have been assigned a single ATCS Address.
  - ATCS addresses assigned for various transit applications



Railroad Number ***051***: Used to identify all Highway ATC devices communicating across an HRI interface.

Railroad Number ***052***: Used by Wayside devices communicating across an HRI interface to identify non-ATCS assigned railroads such as light rail or transit systems.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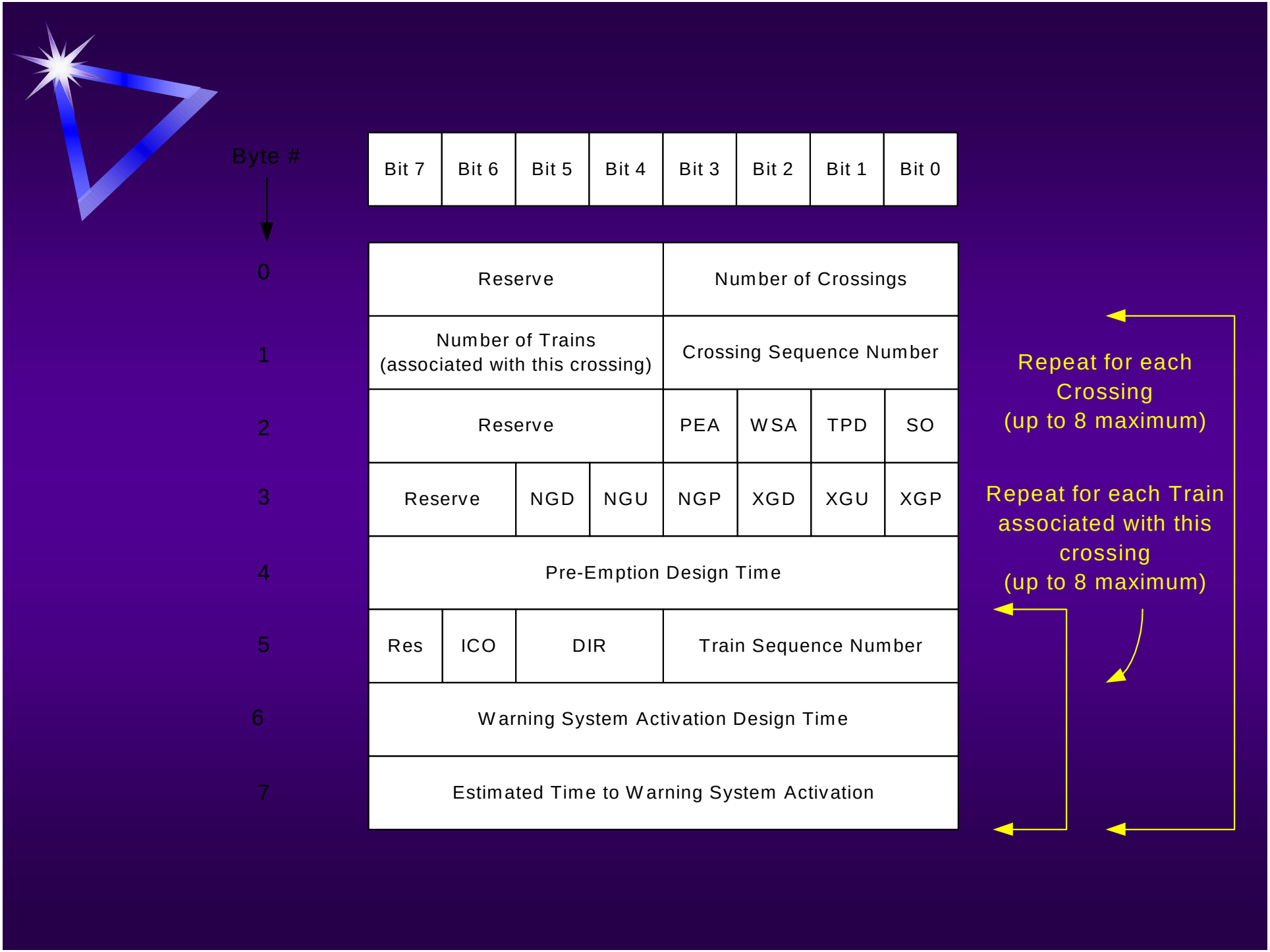
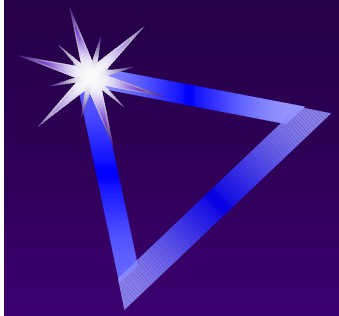
HRI Virtual Interface
ATC Functions
Internal ATC Equipment Network
ATC Gateway
Vehicle Presence Detector
Traffic Controller
Event Recorder
ATC Function

Message ID	Message Name	Source	Destination
9.4.40	HRI Rail Crossing Operational State	Railroad System	**Roadway** System
9.4.41	HRI Approaching Train Information	Railroad System	Roadway System
9.1.41	HRI Approaching Train Information Request	Roadway System	Railroad System
9.4.42	HRI Wayside Equipment Status	Railroad System	Roadway System
9.1.42	HRI Wayside Equipment Status Request	Roadway System	Railroad System
9.4.43	HRI Roadway Obstacle Detection State	Roadway System	Railroad System
9.4.44	HRI ATC Equipment Status	Roadway System	Railroad System
9.1.44	HRI ATC Equipment Status Request	Railroad System	Roadway System
9.4.45	HRI User Specific Wayside Message	Railroad System	Roadway System
9.1.45	HRI User Specific Wayside Message Request	Roadway System	Railroad System
9.4.46	HRI User Specific ATC Message	Roadway System	Railroad System
9.1.46	HRI User Specific ATC Request	Railroad System	Roadway System

Message Content

- **Rail to Highway**
  - Safety Critical
    - Time to Warning System Activation
      - Per train allowing for second train warning
    - Warning system Active, Pre-emption active
    - Gates Up/Down (Entrance/Exit)l
    - Island Occupied
  - Informative
    - Train ETA and length of closure
    - Operational Health of Equipment


Byte #
Bit 7
Bit 6
Bit 5
Bit 4
Bit 3
Bit 2
Bit 1
Bit 0
0
Reserve
Number of Crossings
1
Number of Trains (associated with this crossing)
Crossing Sequence Number
2
Reserve
PEA
WSA
TPD
SO
3
Reserve
NGD
NGU
NGP
XGD
XGU
XGP
4
Pre-Emption Design Time
5
Res
ICO
DIR
Train Sequence Number
6
Warning System Activation Design Time
7
Estimated Time to Warning System Activation
Repeat for each Crossing (up to 8 maximum)
Repeat for each Train associated with this crossing (up to 8 maximum)



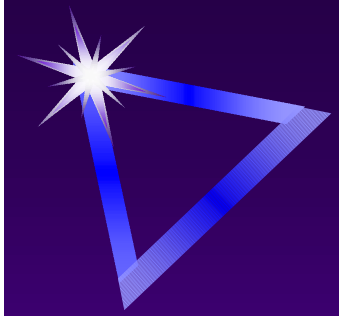
Byte #	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Crossing Sequence Number				Train Sequence Number			
1	Train Classification							
2	Train Movement Plans							
3	Estimated Time of Arrival (high order byte)							
4	Estimated Time of Arrival (low order byte)							
5	Estimated Time of Departure (high order byte)							
6	Estimated Time of Departure (low order byte)							
7	Estimated Speed at Crossing							
8	Estimated Train Length (high order byte)							
9	Estimated Train Length (low order byte)							
10	Reserve							DIR

Message Content

- **Highway to Rail**
  - Safety-Critical
    - Vehicle Present on Tracks
    - Single Vehicle stopped on rail for extended period of time
    - Status of Vehicle Arrestor Barriers or equivalent
  - Non Safety-Critical
    - Operational Health

BALLOTING STATUS

- **23 Balloting Members**
  - 21 Affirmative (91%)
  - 1 Negative (easily resolved)
  - 1 Negative (just didn’t like it)
- **Changes to be made to draft based on affirmative comments**
- **Submit to IEEE for publishing**



Finally, He's Done

Questions?